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Sub-extracting out of the Icelandic *ABA problem

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Icelandic nominal declension show (acc = dat) ≠ gen syncretisms which go against Caha's (2009) cross-linguistic pattern of of acc > gen > dat and hence seemingly violate the *ABA generalisation (Harðarson 2016; Starke 2017). Proposals to overcome this problem have needed to either allow variation in the fseq (Harðarson 2016), or enrich the fseq (Starke 2017). Here we show that the Icelandic *ABA problem can be solved while keeping to Caha's (2009) fseq, and without adding mechanisms to the standard theory of Nanosyntax. The key to the solution lies in the phonology of Icelandic, together with a recent reformulation of the nanosyntactic algorithm in terms of pied-piping.

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1 Introduction

Icelandic singular noun inflections show unexpected ABA patterns (Harðarson 2016; Starke 2017). The patterns involve either a bare root or a suffix:

(1)

	place_{SG}	$\text{sleeve}_{\text{SG}}$	queen_{SG}
ACC	stað	erm-i	drottning-u
GEN	stað-ar	erm-ar	drottning-ar
DAT	stað	erm-i	drottning-u

This is surprising given the recurrent cross-linguistic pattern of syncretism targeting adjacent cells in a ACC < GEN < DAT hierarchy (Caha 2009), illustrated here by Czech:

(2)

Czech	man_{SG}	two_{MASC}
ACC	muz-e	dv-a
GEN	muz-e	dv-ou
DAT	muz-i	dv-ou

The *stað* pattern is a subtly different type of ABA compared to the *ermi* and *drottning* patterns. A nanosyntactic lexicalisation table brings this out clearly:

(3)

stað	
stað	ar
stað	

(4)

erm	i
erm	ar
erm	i

In *stað*, the case layer is co-lexicalised by the root in the accusative and dative, creating an A/Ax/A pattern (A = *stað* and x = *ar*). In *ermi* and *drottning*, case is lexicalised independently, a classical ABA pattern. We will call the A/Ax/A pattern a 'protruding ABA' and the classical ABA pattern in (4) a 'pure ABA'.

We aim to show two things in this article: once phonology is taken into account, all of the Icelandic paradigms above are 'protruding' ABAs; and current nanosyntax derives precisely the fact that protruding ABAs are possible while pure ABAs are impossible. A morphology of the

Icelandic type is thus what is expected under Caha's ACC < GEN < DAT hierarchy (once phonology is teased out).[1]

2 The *ABA theorem

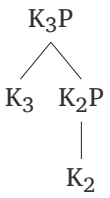
The Nanosyntax lexicalisation algorithm makes it impossible to derive pure ABA patterns, which is both overwhelmingly correct empirically (e.g. Caha 2009; Baunaz et al. 2018; Caha & De Clercq & Vanden Wyngaerd 2019; Starke 2021; Cortiula 2023; Caha & De Clercq & Vanden Wyngaerd 2025 among many others), and problematic for the Icelandic singular declensions of *ermi* and *drottning* above. Let's first see how ABA is ruled out, by trying (and failing) to build the derivations and lexical entries for the *i / ar / i* pattern found with *erm*.

Nanosyntax builds on single (unary) features in terminals and lexicalizes phrases. The ACC/GEN/DAT cases above are for instance argued by Caha (2009) to decompose into cumulative features such that ACC is composed of *[K2 …]*, GEN of *[K3 [K2 …]]*, and DAT of *[K4 [K3 [K2 …]]]* (Caha has an additional K1 feature linked to the nominative, which is irrelevant to us here, see fn1).

A phrase built by syntax can be lexicalised if a structurally identical phrase is found in the lexicon (Starke (2009), see also De Clercq et al. (2025)). This means that the morphemes corresponding to a genitive or a dative, must respectively contain a K_3P and a K_4P in their lexical entry.

The genitive morpheme *ar* could for instance have the following lexical entry:

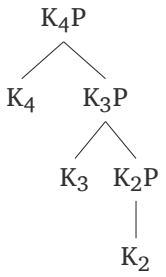
(5) *ar* ⟷



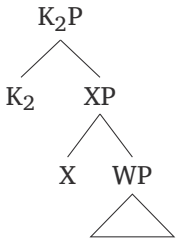
The dative morpheme *i* of the *erm* paradigm might then be:[2]

[1] This paper focuses on showing that the Icelandic ABA pattern can be solved in a cross-linguistically uniform way. Since the Icelandic nominative doesn't participate in the ABA pattern, we leave the nominative aside. Similarly, there are additional ACC/GEN/DAT ABA paradigms in Icelandic. Their logic is however the same as presented in the text, so we leave them aside here; they would not add anything to the logic of the solution. Once the logic of the solution is established, it is important to us that it can also handle the nominative and the "smaller" paradigms, we therefore dedicate a complementary paper to showing that the logic established here extends to the full spectrum of the Icelandic facts.

[2] These entries are meant to illustrate how the *ABA works in Nanosyntax. Both will be changed below when we address the Icelandic pattern.

(6) $i \longleftrightarrow$ 

The morpheme *i* can also lexicalise accusative case, and indeed, accusative is a K_2P, and a K_2P is found in (6). We thus seem all set for the *i / ar / i* pattern. Let's try to derive it step by step, starting at the accusative layer:

(7) 

When syntax builds the accusative structure above, we might expect (6) to match (7). But that's impossible due to the requirement of structural identity: the K_2P in (6) is not structurally identical to anything in (7). For one, the K_2P in (6) is unary branching while the K_2P in (7) is binary branching. The lexical entry (6) hence does not match the syntactic structure (7).

In such situations, Nanosyntax allows for last-resort displacement, called "evacuations", which attempt to rescue the lexicalisation. In traditional Nanosyntax, evacuation affects either the sister node of the feature just merged, or the left daughter of that node. The relevant part of the algorithm is thus informally:

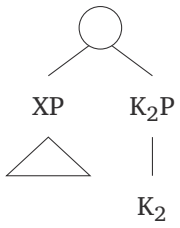
(8) After merging a feature to a structure τ:
- a. lexicalise
- b. on failure, evacuate the left daughter of τ and lexicalise
  (similar to spec-to-spec movements)
- c. on failure, evacuate τ instead, and lexicalise
  (similar to rollup movements)

Evacuations always target phrasal nodes, and since they are not feature-driven movement but rather lexicalisation-driven, they do not leave traces and do not project labels.[3]

[3] Traditional Nanosyntax has the usual feature-driven movements such as long-distance wh-movements, and those leave the usual traces (or equivalent) and participate in the usual labelling.

In the case of (7), the feature K_2 was merged with XP, and hence XP is the relevant τ for the lexicalisation algorithm above. The first rescue attempt would then evacuate the left daughter of XP, i.e. the terminal X, but since only phrases evacuate (or more generally move), that doesn't work out. The next attempt evacuates XP, yielding (9) (we indicate the lack of label by circling the relevant node):

(9)



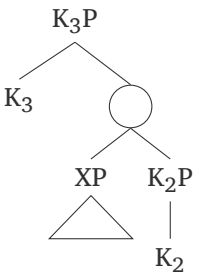
The right branch of (9) does now have a structurally identical phrase in the lexicon: the smallest constituent of the lexical item (6) for *i* is identical to the right branch of (9). The lexeme (6) can thus in principle lexicalise the right branch of (9), resulting in a suffix *i*.

We however need to take care of one competitor before we reach that conclusion: the right branch of (9) is also exactly identical to the K_2P in the lexical entry (5) for *ar*. The lexeme (5) is thus another candidate to lexicalize it. When multiple lexical items compete to lexicalize a given phrase, the Elsewhere Principle regulates the choice of the lexicaliser: the lexical entry whose stored phrase applies to fewer contexts is the lexicaliser. (In practice, that typically amounts to the candidate with the fewer unused nodes during matching, and hence the smallest candidate.)

That's bad news for the ABA: the entry (5) for *ar* applies in fewer contexts (i.e. is more specific) than the entry (6) for *i*. The entry (5) applies in the accusative and genitive, whereas the entry (6) applies in the accusative, genitive and dative. Our accusative structure would thus be realized with the suffix *ar*. We will thus not derive our intended *i / ar / i*, but rather *ar / ar / i*.

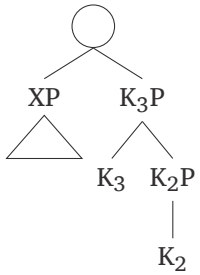
Let's briefly see the genitive and dative derivation to confirm this. Now that the K_2P cycle is successful, the derivation moves on to the K_3P cycle by merging K_3.

(10)



Since it is impossible to lexicalise this K_3P with our lexical items, last-resort evacuation applies. τ is now the unlabelled node, the first target of evacuation is thus XP, its left daughter, yielding:[4]

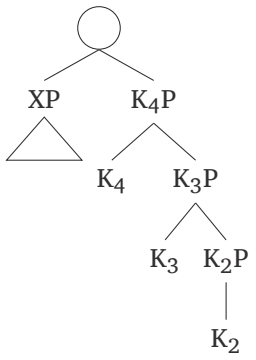
(11)



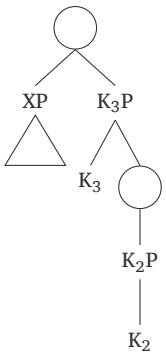
Again, both lexemes (5) and (6) contain a K_3P structurally identical to K_3P in (11), and hence both are candidates to lexicalize it. The entry (5) for *ar* is now an exact match, whereas the entry (6) for *i* contains an unused node, i.e. K_4P. The genitive (11) thus surfaces with an *ar* suffix, just like the accusative.

Now that the K_3 lexicalized successfully, the derivation proceeds to the K_4 cycle. Simply merging K_4 will not lexicalize, just like above, triggering evacuation, which will create:

(12)



[4] The new tree might be expected to be:



Nanosyntax however has a convention of pruning the non-branching intermediate nodes (such as the lower unlabelled node), which results in (11).

The right branch K_4P is now exactly identical to the lexical entry (6). No other lexical entry has such a phrase, and hence the entire dative K_4P will be lexicalised by (6).

When a higher phrase is lexicalised, its lexicalisation takes scope over its entire constituent, overriding the lexicalisation of earlier, smaller phrases contained in the newly lexicalised bigger phrase. In this case, the lexicalisation of K_4P by the lexical entry (6) as *i* overrides the earlier lexicalisation of K_3P by the lexical entry (5) as *ar*.

We thus derived *ar / ar / i*, (an AAB paradigm), and failed to derive *i / ar / i* (an ABA paradigm). This is because it is impossible for *i* to be both bigger than the genitive *ar* and be the best match for the smaller accusative. A 'pure' ABA is underiveable.

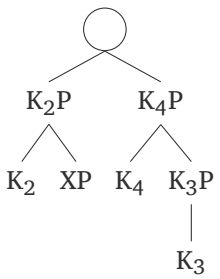
3 Blixemes

The work of Blix (2021; 2022) and Caha (2021b) led to the discovery that one very special subtype of ABA-like pattern, the 'protruding ABA' pattern, can be derived within standard Nanosyntax, and that this pattern is in fact attested. This pattern contains a root and exactly one suffix, with the bare root alternating with the suffixed form: *Root / Root-x / Root*. While Blix discovered the underlying logic and applied it to make sense of apparently contradictory declensions within a single language, Caha (2021b) extended it to *Root / Root-x / Root* patterns.

Blix's discovery makes use of an under-explored possibility of traditional Nanosyntax: since any well-formed syntactic structure can be stored in a lexical entry, a structure including evacuation movement can also be stored in the lexicon. In practice, mostly syntactic structures built by merging features were traditionally stored in the lexicon – structures without complex left branches and without movement (though see Starke 2014; Wiland 2019: 65 inter alia).

To show that lexemes with evacuation allow *Root / Root-x / Root* patterns, let's assume the following lexical entry for the noun *stað* which surfaces bare in the dative:

(13) *stað* ⟷

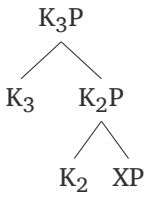


Here K_2P has evacuated over K_3 and K_4, and this evacuated structure has been stored in a lexical entry. We will call such lexical entries 'Blixemes'.

When syntax builds an accusative structure, *[K_2 XP]*, it is now exactly matched by the left branch of the lexeme (13), and hence *stað* will be able to realize an accusative by itself.

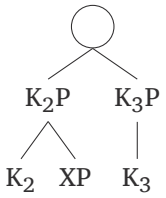
If syntax builds a genitive, K_3 is merged into the syntactic structure:

(14)



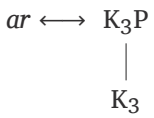
This structure cannot be lexicalised by the lexical item (13) or any other lexical item above. This failure to lexicalise triggers last-resort evacuation movement, yielding:

(15)



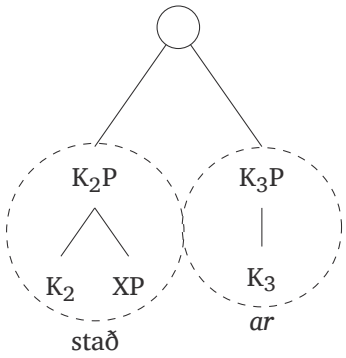
Here *stað* is able to lexicalise the left branch (K_2P), leaving the constituent K_3P to be lexicalised independently: This is what the genitive marker *ar* lexicalises. We thus update the lexical entry for *ar* to: (this will be its final form for the rest of the paper)

(16)



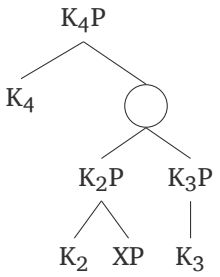
Our derivation (15) now lexicalises as:

(17)



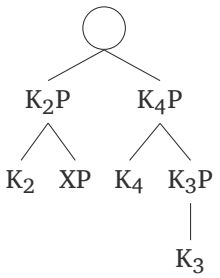
We thus correctly derived the accusative *stað* and the genitive *stað-ar*. The Blixemic effect hits when the derivation continues with K_4, turning the genitive into a dative:

(18)



Since K_4P cannot lexicalise, evacuation is triggered:

(19)



The resulting structure exactly matches the lexical entry for *stað* in (13). We thus derive *stað* for both the accusative and the dative, but *stað-ar* for the intervening genitive. This thus derives a 'protruding ABA' pattern while changing neither the rules of Nanosyntax nor the universal functional sequence NOM < ACC < GEN < DAT.

This kind of lexicalisation was a pleasant surprise discovered by Blix and Caha, and fits this Icelandic paradigm perfectly. That kind of lexicalisation however holds only under very select conditions: the intermediate form *must* have an additional morpheme wrt. the two peripheral forms, and the two peripheral forms *must* be bare roots (i.e. cannot contain suffixes). As a result, this solution derives the protruding *A / A-x / A* pattern in *stað*, but it cannot derive 'pure ABA' patterns.

4 Undoing phonology

The paradigms for *erm* and *drottning* look like traditional 'pure ABA' patterns, not like the 'protruding' A/Ax/A pattern (more precisely *Root-a / Root-b / Root-a*, not *Root / Root-b / Root*), and hence remain underivable:

(20)

	sleeve$_{SG}$	queen$_{SG}$
ACC	erm-i	drottning-u
GEN	erm-ar	drottning-ar
DAT	erm-i	drottning-u

or simply:

(21)

	sleeve$_{SG}$	queen$_{SG}$
ACC	i	u
GEN	ar	ar
DAT	i	u

Appearances can however be misleading. It is widely assumed in the Icelandic literature that vowels delete regressively under hiatus (Dehé 2008; Gleim 2024; Sigurðsson 2001; Árnason 2011).[5] Árnason (2011: 254) notes that this is restricted to vowels typical of inflectional endings, the historically native unstressed vowels [a, ɪ, ʏ]. The list below shows examples of regressive vowel deletion in inflection.[6]

(22)
a. laiknɪ-a → laikna ‘doctor’ gen.pl.
b. laiknɪ-ʏm → laiknʏm ‘doctor’ dat.pl.
c. nira-ʏm → nirʏm ‘kidney’ dat.pl.
d. kʰatla-ʏm → kʰœllʏm ‘call’ 1.pl.pres.
e. kʰalla-ɪð → kʰatlɪð ‘call’ 2.pl.pres.

(Gleim 2024:129)

Regressive vowel deletion in hiatus is also seen across word boundaries. The examples below show instances of this for each of the traditional vowels targeted by deletion. The vowels with a strike-through in each example drop in front of the vowel of the following word:[7]

(23) (Ég) talaa um það
(I) talk about it

(24) (Ég) taimi hana (Sigurðsson 2001:7)
(I) judge her

[5] One exception to regressive deletion is seen when the definite suffix is attached to a stem, triggering progressive vowel deletion.

[6] Note that the initial vowel survives outside of hiatus. Contrast for instance (22a) with *lækni-s*(gen.sg) which surfaces as *læknis*.

[7] (Sigurðsson 2001: 7) gives (24) as an example of hiatus resolution across a word boundary since the *h* is silent for him. However, some speakers do pronounce it, and hence this example is irrelevant for those speakers.

(25) Allir kom~~y~~ og horfð~~y~~ á Kalla. (Dehé 2008:746–747)
Everybody came and looked at Kalli.

Given this backdrop, it becomes conspicuous that the *i* vowel of *erm* nouns and the *u* vowel of *drottning* nouns are missing exactly when they would be followed by another vowel - that is, exactly when they would be the regressive member of a hiatus configuration. As a result, if their underlying form was:

(26)

	$\text{sleeve}_{\text{SG}}$	queen_{SG}
ACC	i	u
GEN	i-ar	u-ar
DAT	i	u

we would expect the first vowel to delete in the genitive and their surface paradigm to be exactly (21).[8]

Given this interpretation, these paradigms do in fact have an A/Ax/A shape reminiscent of the blixemic pattern, and not the impossible *ABA pattern.

Remember however that the mechanics of the blixemic solution restrict it to bare roots: A must be a (bare) root. But with *drottning/erm* nouns, A is a suffix, not a root. The full paradigm is of the shape *Root-a / Root-a-x / Root-a* instead of *Root / Root-x / Root*:

(27)

	queen_{SG}	$\text{sleeve}_{\text{SG}}$
ACC	erm-i	drottning-u
GEN	erm-i-ar	drottning-u-ar
DAT	erm-i	drottning-u

It will thus be useful to explicitly distinguish two subtypes of 'protruding ABA' patterns: 'root-protruding ABA' in which A is a root, and 'suffix-protruding ABA' in which A is a suffix. Our solution for *stað* is applicable to 'root-protruding ABAs' and is thus still inapplicable to the 'suffix-protruding ABA' in *erm/drottning*. However, another development in Nanosyntax derives 'suffix-protruding ABAs', resolving the *erm/drottning* puzzle in (27).

5 Subextraction

Motivated by a puzzle in Brazilian verbal inflection, Starke (2022) simplified the algorithm for lexicalisation-driven movements. Instead of stipulating which constituents can undergo

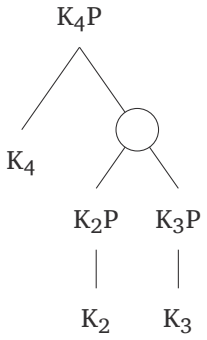
[8] We have not found a clear case of an *u* being regressively deleted under hiatus at a morpheme boundary specifically. There are examples at function-word boundaries, cf (25). The conjunction of this fact with the regressive deletion of *a* and *i* at morpheme boundaries makes a plausible case for the general availability of regressive vowel-deletion under hiatus, especially given that application at a stronger boundary tends to imply application at a weaker boundary (see e.g. (Stanley 1973)). The approach we propose is of course conditional upon that.

evacuation, and in which order the evacuations are attempted, Starke (2022) proposes that the target of evacuation obeys a simple locality restriction: it is always the closest labelled node containing the bottom of the tree (i.e. containing the noun stem, in our case). If that movement fails, the same node gradually pied-pipes the constituents containing it – deriving both which constituents are evacuated and in which order the operations are attempted.

(28) After merging a feature f to a structure τ:
   a. lexicalise
   b. on failure, evacuate the 'bottom' – the labelled node closest to τ, containing the bottom of the tree – and lexicalise
   c. on failure, iteratively pied-pipe the bottom, and lexicalise

Applying this to the derivation of the (underlying) *erm* paradigm (27) will suggest the following lexical entry for *i*:

(29) *i* ⟷

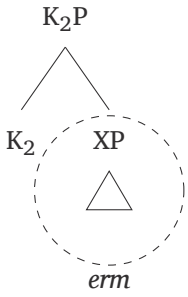


Let's get there step by step. Since the root plays no interesting role in these derivations, it will simply lexicalize XP. We will keep throughout the simple entry (16) for *ar*, repeated here:

(30) *ar* ⟷

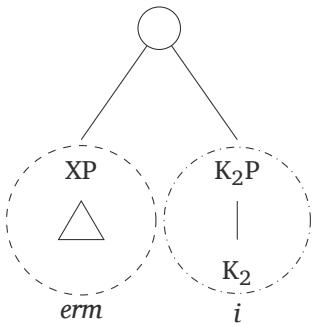
Starting at the accusative layer as usual, we get:

(31)



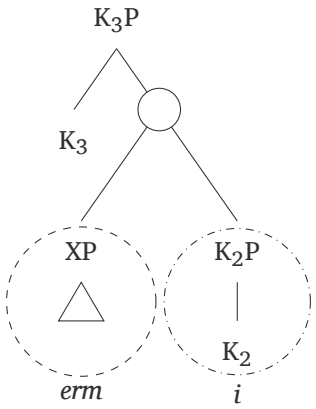
This cannot be lexicalised given our lexicon above. The closest labelled node containing the bottom of the tree is XP, so XP gets evacuated:

(32)



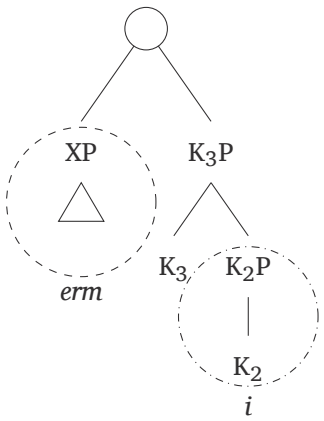
The right branch now matches a constituent of the lexical entry (29), the accusative thus lexicalises as *erm-i*. The derivation can proceed with K_3, creating a genitive out of the accusative:

(33)



Again, K_3 cannot be lexicalised in this configuration, evacuation is triggered. The τ node for the algorithm (28) is the unlabelled node, and from there, the closest label containing the bottom of the tree, is XP. Evacuating this bottom results in:

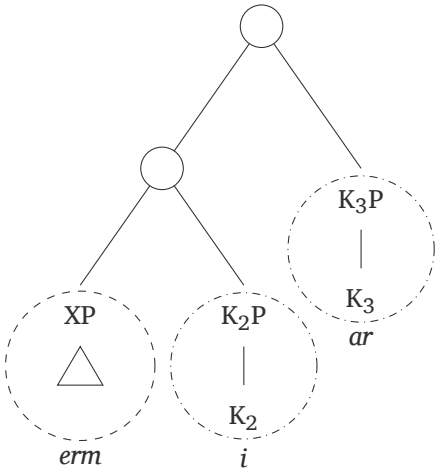
(34)



This configuration still doesn't allow the K_3 feature to be lexicalized: the *ar* lexical entry (30) does not match, and neither does any other entry. Since this evacuation didn't work out, pied-piping is

attempted instead: the same XP evacuates, but this time it pied-pipes its containing constituent, the unlabelled node in (33):

(35)

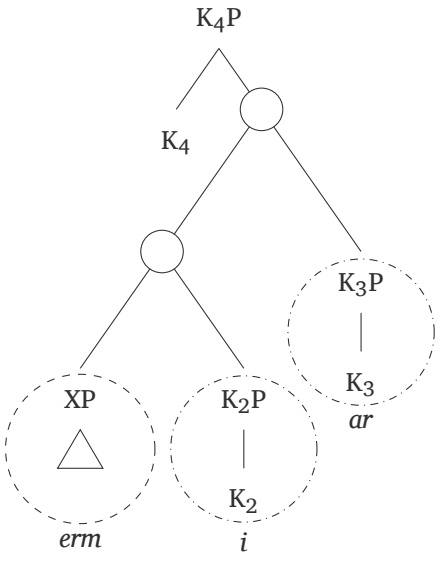


K_3P now matches the lexical entry for *ar*, correctly deriving the genitive *erm-i-ar* which hiatus resolution will resolve to *ermar*.

The derivation so far shows that the new algorithm derives the same evacuations as the classical algorithm, but in a cleaner, more principled way. At this stage, we encounter a novelty: the traditional algorithm limits the evacuations to two levels (τ and its left daughter), whereas the pied-piping version has no limit to the depth of evacuation and pied-piping. Put differently, beyond removing the need to state one by one which node can evacuate, and the need to state one by one which order the evacuations are attempted in, the new algorithm also removes the stipulation about the possible depth of the evacuation.

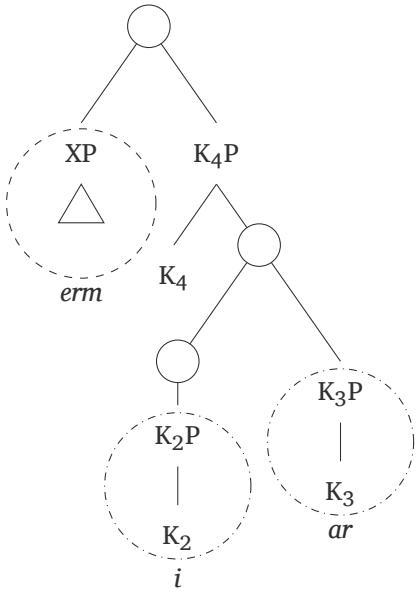
This makes a crucial difference at our current stage of the derivation. Let's merge K_4:

(36)



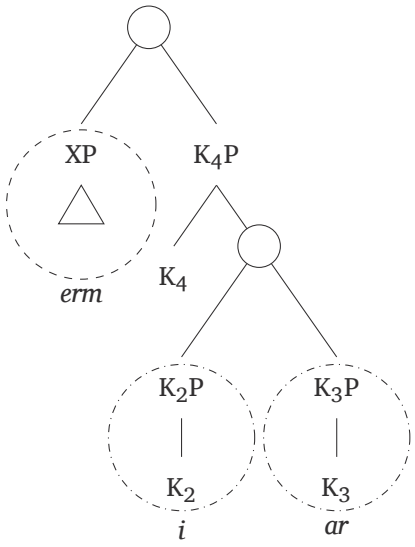
As usual, the top K feature fails to lexicalize. The traditional algorithm would have picked the lower unlabelled node as the first node to evacuate. The newer pied-piping version however picks XP, since it is the closest labelled node containing the bottom of the tree. This creates a sub-extraction configuration, in which XP sub-extracted out of the lower unlabelled node:

(37)



and once the non-branching intermediate node is pruned (cf. fn4):

(38)

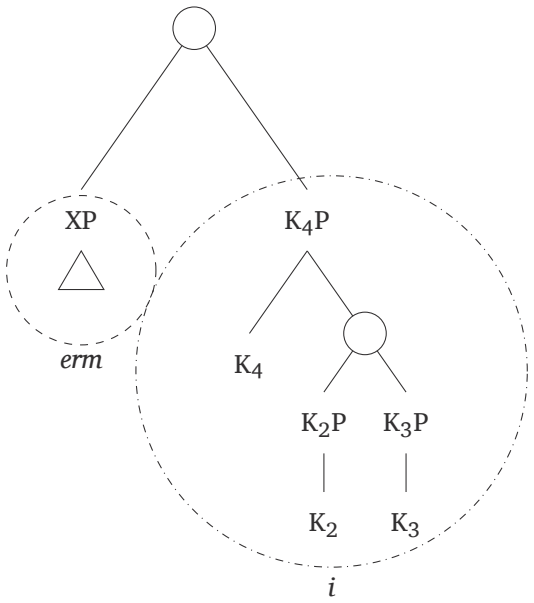


As a result of this evacuation, the two suffixes *i* and *ar* form a constituent. This allows a new situation in Nanosyntax: two suffixes form a constituent excluding the root (or stem), and hence can be overridden by a single suffix.

If the overriding suffix is *i* itself, we not only override two suffixes with one, but we also recreate the Blixemic A/Ax/A logic, now with A itself a suffix. This result is exploited in numerous recent Nanosyntax contributions (see e.g. Caha 2023; 2024; Cortiula 2023; Dalen 2023; De Clercq

et al. 2025). We can infer from this that the lexical entry for *i* is exactly K_4P above, whence the entry (29). The dative thus lexicalises as:

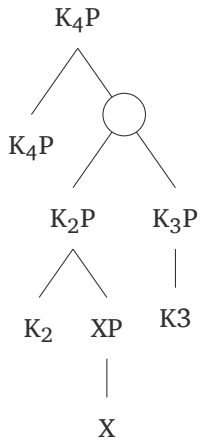
(39)



We have therefore derived the *erm-i / erm-i-ar (> ermar) / erm-i* paradigm, and in doing so, used only pre-existing tools: Caha's universal case hierarchy and the standard tools of Nanosyntax. It also remains the case that a 'pure ABA' pattern of the type *erm-i / erm-ar / erm-i* is not derivable.

The same logic applies to the *drottning* class of roots, with the intermediate suffix *u* instead of *i*.[9] Since our focus is on apparent *ABA violations and not on root selecting suffixes, we will side-step this difference; noting that selection is a mark of different root size (cf. (Caha 2021a; Caha & De Clercq & Vanden Wyngaerd 2019; De Clercq & Vanden Wyngaerd 2017; Márkus 2015; Taraldsen 2010) and many others). The lexical entry for *u* could be (again, ignoring K_1 for the purpose of this paper):

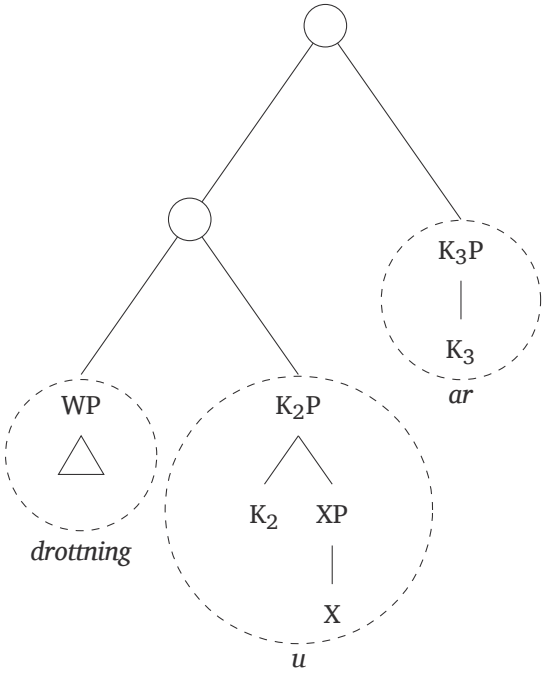
(40) *u* ⟷



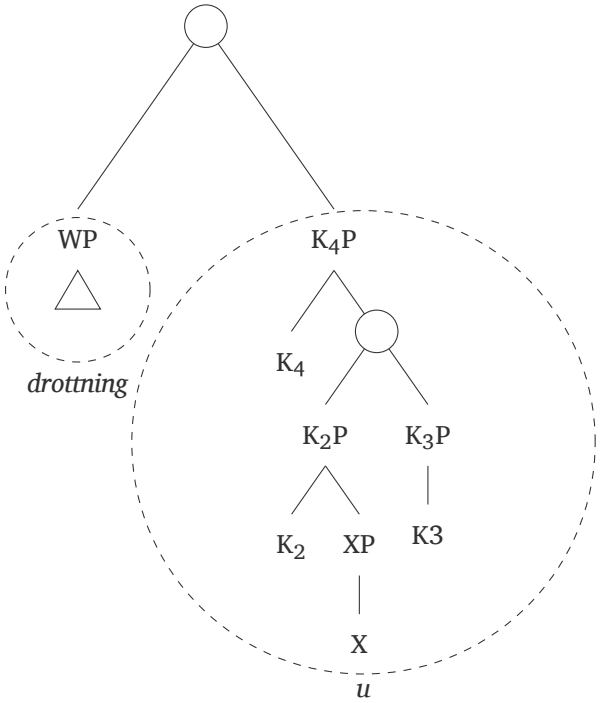
[9] This class of nouns is morphologically complex, ending with the suffix *ing*. This will ultimately have no effect on the lexicalisation of the case suffixes, and can also be bypassed by looking at proper nouns such as *Elísabet* which decline like *drottning* but do not have a morphologically complex root.

The relevant representations of genitive and dative of *drottning* would look like this:

(41)



(42)



6 Umlaut: A tentative extension

The *∅/ar/∅* pattern has an interesting variant:

(43)

	gift$_{SG}$	
ACC	gjöf	
GEN	gjaf	-ar
DAT	gjöf	

The genitive suffix is the same as in *stað*, but the root undergoes umlaut in the accusative and dative.

If the umlauting was a purely phonological process, the paradigm would be morpho-syntactically identical to *stað*. We would however like to point out a possible extension of the analysis, building on the traditional idea that there is a trigger for the umlaut, and that this trigger lives after the root.

In Icelandic phonology, an underlying *a* vowel turns into an *ö* in front of an *u*, an alternation known as *u-umlaut* (Anderson 1969a; b; Gibson & Ringen 2000; Hansson & Wiese 2024; Ingason 2016; Thráinsson 2017; Árnason 1985). For instance, the *a* of *stað ('place')* changes to *ö* when suffixed by an *u*-inital suffix (44).

(44) stað-um → stöðum (place, dative plural)

This alternation is however also seen in morphosyntactically defined environments without a visible trigger, such as the nominative and accusative plural of neuter nouns (45):

(45) barn → börn (child, nom/acc.pl.)

Ingason (2016: 220–221) provides interesting evidence that such cases are productive: it also applies to nonce words and loanwords. For instance, he shows that the non-existent word *nar* gets pluralized to *nör*, on a par with the above *barn* being pluralized to *börn*.

How are these cases of umlaut triggered? The literature proposes several mechanisms, from Anderson (1969a; b) proposing an underlying *-u* suffix which gets deleted, to Svenonius (2025) proposing a floating feature bundle, through several proposals in between with different technologies, e.g. Gibson & Ringen (2000); Svenonius (2012); Ingason (2016). We hope to come back to these phonological issues surrounding umlaut in Icelandic in later work; in the meantime we will remain neutral, notating the trigger as a superscript *-u*:

(46) barn^{u} → börn (child, nom/acc.pl.)

Applying this to the *gjöf* paradigm, we get the following underlying representations:

(47)

	gift$_{SG}$	
ACC	gjaf	u
GEN	gjaf	ar
DAT	gjaf	u

This in fact corresponds to the diachrony of *gjaf*: nouns of the *gjöf*-class were followed by an *-u* at an earlier historical stage.

As a result, the *gjöf* paradigm now looks underlyingly more like the *drottning* paradigm than the *stað* paradigm. This in turn suggests the same logic as for *drottning*: the underlying $^{-u}$ is also present in the genitive, but gets inhibited (i.e. bled), either by hiatus resolution or by another phonological mechanism, which we hope to come back to in later work:

(48)

	gift$_{SG}$		
ACC	gjaf	u	
GEN	gjaf	u	ar
DAT	gjaf	u	

The familiar syntactic derivation discussed in previous sections now derives the apparent ABA pattern from standard nanosyntactic steps, but also derives the fact that we see umlaut in ACC and DAT but not in GEN.

7 Conclusion

Icelandic noun declension is known to contain ABA-patterns contradicting Caha's (2009) case decomposition. We have shown that with careful attention to phonology, the patterns are likely to be 'protruding ABA' patterns of the type A/Ax/A, and not 'pure ABA' patterns. In recent work, Blix and Caha have discovered that 'protruding ABA' patterns of the shape A/Ax/A follow from the standard Nanosyntax tree-building algorithm (while 'pure ABA' patterns remain underivable). Their results, together with the underlying phonology of Icelandic, allow us to derive the apparent ABA patterns from standard (nano)syntax.

There is thus no need to postulate variation in the functional sequence across languages (Harðarson 2016) and no need to enrich the universal functional sequence with a second dative-like feature (Starke 2017). The Icelandic nominal declensionw patterns falls out cleanly from vanilla Nanosyntax.

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Competing interests

The authors have no competing interests to declare.

Authors' contributions

Both authors contributed equally to this article.

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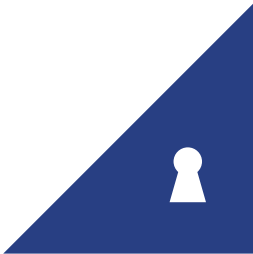
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